Process for accurately timed automatic alteration of electrical signals stored on a signal carrier, in particular magnetically recorded audio signals and video signals, during the transmission of the original signal to a signal receiver

The invention originates from a process for accurately timed automatic alteration of electrical signals stored on a signal carrier, in particular magnetically recorded audio signals and video signals, during the transmission of the original signal to a signal receiver, according to the preamble of the main claim. Such processes are used, for example, in professional or semi-professional sound studio engineering in connection with a multi-channel sound recording device, a multi-channel mixing desk for mixing the channels of the multi-channel sound recording device for the recording on a stereo sound recording device, and a plurality of effect processors, such as gates, compressors, expanders, reverberation and echo devices, in the signal paths between the multi-channel sound recording device and multi-channel mixing desk, which effect processors are controlled by direct-voltage-controlled setting elements. A sound studio device of this type is used for so-called stereo mixing of the audio signals stored on the multi-channel sound recording device, which signals were stored on the individual channels in a manner such that they were separated according to instruments, instrument groups and speech.

Such an alteration of the original signal, for example correction of faults or defects of the original sound recording, was hitherto carried out alongside the volume control of the individual sound channels, generally by hand during the mixing.

Because of the plurality of channels to be mixed

and the unsatisfactory reaction time of the operator of this equipment, it is, when working manually, only possible to carry out a rough correction for all of the faults or defects which occur, at best separately according to fault types, which have to remain maintained during the entire playback of the sound recording medium or at least for a comparatively long time. In this way, it is not possible for faults or defects of the original signal that have been established to be corrected dynamically during the mixing, i.e. for each fault to be ironed out individually and separately.

A process for mixing a sound event, which was recorded in the form of a plurality of partial sound events, into a two-track stereo version has also become known (DE-OS 20 01 493), in which process the control signals which occur during the mixing are stored on a free track of the multi-channel recording device in order that they are retained, and one audio track after the other is processed or the mixing is repeated and the mixing program can be corrected. With this process, an automatic control of steady transitions and fade-outs is admittedly possible, but not, however, the correction of individual, precisely determined defective spots, such as throat-clearing, hissing noises or suchlike. A further disadvantage of this process consists in that a plurality of tracks on the multi-channel recording device has to remain reserved for the control signals, and the capacity of the device is thus reduced.

The object of the invention is therefore to present a process which makes it possible to carry out an accurately timed automatic alteration of electrical signals stored on a signal carrier during the transmission of the original signal to a receiving device and which does not have the disadvantages of the

known process.

This object is achieved by a process in accordance with the preamble and having the characterising features of the main claim. This process has the advantage that no signal tracks on the signal carrier of the original signal have to be reserved for the correction signals for altering the original signal; instead, all signal tracks are available for original-signal recordings.

A further advantage of the process consists in that as a result of the analog graphical representation of the digitally stored original signal, a precise localisation of the area of the correction spot is possible. From this results the advantage that the desired signal alteration starts exactly at the required instant and also stops exactly at the required instant, so that, for example, an optimal correction of defective spots is ensured without residual defective spots and without impairing non-defective spots. Because the original signal, which is provided with a time code, is stored digitally in the memory unit of the computer, the advantage results that the processing of this signal can take place independently of the original recording, so that a repeated playback of the original recording is not required for the processing in order to carry out the desired alterations at the correct spots. Furthermore, the search for the spots to be processed is speeded up as a result. The correction spots can first of all be localised roughly by way of the time code and/or by an acoustic preliminary check by the operator of the equipment, in order then to establish the correction area precisely with the aid of the graphical representation.

The process is carried out in three steps. In the first step of the process, the original signals on a signal carrier are digitized and, provided with a time

code, are supplied to a data memory. If the original signals are already present in digital form, the digitization step can, of course, be omitted. In the second step, the stored digitized original signals are represented graphically, preferably in analog form, and checked for spots to be corrected, and corresponding correction signals are stored synchronously with the original signal. Individual parameters of the original signal, such as its loudness, frequency range and suchlike, can also be represented digitally for checking and alteration. Thus, for example, the loudness level of the original signal can be displayed digitally in order to be dynamically influenced by an appropriate setting element. Because the original signals are also present in digital form in the data memory, it is not only possible for all channels to be processed independently of each other, but the processing can also take place at any instant at any spot on the entire signal recording. Additionally, it is possible to check each individual processing step, even channel by channel, by synchronous playback of the original recording, or even to check entire passages both individually and in combination with one or more other signal tracks. The third step consists in the transmission of the signals to a receiving device, for example in the mixing and stereo recording of audio signals, by playing back the stored correction signals synchronously with the original recording, and the original signals are thus transmitted automatically in an accurately timed and dynamically altered manner to the receiving device, for example stereo sound recording device.

Therefore, the correction measures do not alter the original signals either on the original recording or in the digital data memory, but instead only in the playback loop, thus, for example, in the mixing desk

and, if appropriate, in the recording of the stereo sound recording device. As a result of this, it is possible to cancel, expand or improve corrections or to generate different variants and compare them with each other. The correction signals are thereby synchronised with the aid of a time code which is present anyway on the original recording or is introduced. This time code is transmitted by the signal carrier to the data memory which is used for storing the correction signals.

In addition to the correction of faults, the process in accordance with the invention is also suitable for controlling the use of every type of voltage-controlled effect processor, such as reverberation and echo devices, for example, in all parameters. Thus, among other things, the loudness of audio signals could also be controlled according to this process. In this connection, the advantage also results that the use of these devices can take place dynamically, thus not, as in known processes, by alternating between static settings. Such program alternations are far more complicated and less precise, even if they were to be controlled automatically.

The use of the process in accordance with the invention for processing video signals is used in particular for processing magnetic recordings of such signals before their reproduction over the television. In the case of current affairs reporting, there is often only a little time available between recording and transmission to remove possible image faults. Cutting of the magnetic recording is therefore not generally possible. With the process in accordance with the invention, however, a fast processing can take place without destroying the original.

According to a further development of the invention, the process in accordance with the invention

is used in automatic control technology, in particular in the provision of control programs and control circuits. In this case, the advantage is that a basic program which is present can be altered and tried out without destroying the original program.

According to a further advantageous development of the invention for processing complex original signals, the envelope curve of the complex original signal of each channel of the signal carrier is established and represented graphically in the computer and the check for spots to be processed and the required correction are carried out with the aid of these envelope curves. This has the advantage that, on the one hand, the spots to be processed can be recognised more easily and, on the other hand, the correction measures can be carried out more easily.

According to a further advantageous development of the invention, the graphical representation takes place by means of a screen. This has the advantage that the visible section of the envelope curve is freely selectable and that it is possible to alternate quickly between different regions of the envelope curve. Altogether, the processing is simplified as a result of this.

According to a further advantageous development of the invention, which development relates to multi-channel signal carriers and analog original signals, a plurality or all of the channels of the signal carrier are digitized by way of a common analog-to-digital converter. In order to do this, the analog-to-digital converter has a channel selection function, which can preferably be controlled by way of the computer. As a result of this, different channels of the multi-channel signal carrier can even be pre-selected. As a result of this measure, a saving is made on analog-to-digital converters which would otherwise be required for each

individual channel.

According to a further advantageous development of the invention, the direct-voltage-controlled setting element is connected, with intermediate connection of voltage holding elements, to a plurality of effect processors, which influence the original signal during the reproduction. In order to do this, the setting element has a distributor function, which can be controlled by way of the computer. This development has the advantage that instead of a plurality of direct-voltage-controlled setting elements for controlling effect processors, which setting elements each have to be controlled from the computer, generally one setting element, or at least comparatively few setting elements, is enough to control the effect processors required for the desired corrections. All of the necessary effect processors, such as voltage-controlled amplifiers, filters and suchlike, are therefore actuated by a common direct-voltage-controlled setting element, with an interconnected holding element maintaining the control voltage for each effect processor until the latter is again addressed by the setting element.

Further advantages and advantageous developments of the invention can be taken from the following description, the drawings and the claims.

The drawings show, by way of example, a device for carrying out the process in accordance with the invention. This process is described in greater detail in the following with the aid of the drawings, in which:

Figure 1 shows a block-circuit diagram of this device;

Figure 2 shows the graphical reproduction of the envelope curve of an audio signal; and

Figure 3 shows a graphical representation of a

sequence of correction measures.

A multi-channel sound recording device 1 is provided with a number of sound outputs 2 that corresponds to the number of channels, which outputs are each connected via a sound line 3 to the series-connected effect processors 4, 5, 6 and 7 and subsequently to an input of the mixing desk 8. The mixing desk 8 has a stereo output 9, by way of which it is connected to a stereo recording device 10. In parallel with this signal path 3, the output signal of each channel of the multi-channel recording device 1 is tapped and supplied via the signal path 11, with intermediate connection of, for example, a serial interface 12 and a serial-parallel converter 13, to an analog-to-digital converter 14.

The analog-to-digital converter 14 passes the now digital signal on to a computer 15, in which the signal is stored. In this way, the audio signals of all of the channels of the multi-channel recording device 1 can be stored separately in the computer 15, in which case, by means of a channel selection circuit in the analog-to-digital converter 14, the audio signals of all of the channels can be digitized by a common analog-to-digital converter. The selection function of the analog-to-digital converter can be constructed so as to be controllable from the computer 15. The digital audio signals stored in the computer 15 can be reproduced in analog form channel by channel, preferably in the form of an envelope curve, on a graphic display terminal, in particular a screen 16.

In addition to storing the audio signals, the computer 15 is used to store the synchronised correction signals. These are supplied by the computer 15, by way of a digital-to-analog converter 17, with intermediate connection of, for example, a parallel-serial converter 18 and a serial interface 19, to a

setting element 20, which is connected to the effect processors 4, 5, 6 and 7 with intermediate connection of a respective voltage holding element 21.

In order now to carry out the corrections to the audio signals, the audio signals or the envelope curves thereof are reproduced channel by channel on the screen 16 and the defective spots are sought out. In this connection, the synchronous playback of the sound recording device 1 can be helpful in that the area which is sought is roughly localised by an acoustic check. This area is then examined on the screen 16 for the acoustically detected defective spots and an accurately timed correction is input into the memory of the computer. In this connection, both the instant and the duration of the correction measure can be defined exactly, so that an optimal correction is ensured during the stereo mixing. The same procedure can be followed when using reverberation and echo devices etc.

In this respect, Figure 2 reproduces by way of example an envelope curve which has a defective spot in the form of a high peak, which can be caused, for example, by someone clearing their throat. The start of this defective spot at T1 and its end at T2 can be determined precisely in this representation, so that the corresponding correction measure can also be input into the computer in a precise, i.e. accurately timed manner, and used during the mixing.

Figure 3 shows by way of example a sequence of different types of correction measures, which, with the aid of this process in accordance with the invention can easily be input on the screen and stored permanently in the computer. In the example which is shown: in region I "Delay", in region II "Attack", in region III "Decay", in region IV "Sustain" and in region V "Release". None the less, corrections can be revised if, for example during the trial playback of

the corrected audio signal, an unsatisfactory correction should become evident.

During mixing, all of the input correction means are then carried out automatically in an accurately timed manner. In this connection, the computer 15 passes the control signals via the digital-to-analog converter 17, interface 18 and parallel-serial converter 19 to the setting element 20, which in turn controls one of the effect processors 4, 5, 6 and 7. In order to do this, the setting element 20 has a multiplex function, which can be controlled from the computer 15. All of the effect processors 4, 5, 6 and 7 of a channel can thus be controlled by a single setting element 20, with a respective holding element 21 ensuring that the control voltage lies at the effect processors 4, 5, 6 and 7 until the respective effect processor is addressed again by the setting element 20 and receives a new control voltage.

All of the features represented in the description, the drawing and the subsequent claims can be of significance for the invention both individually and in any combination with one another.